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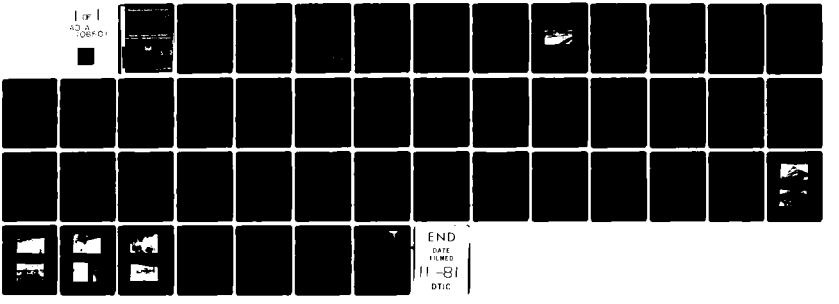

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LAKEWOOD DAM
JACKSON COUNTY, MISSOURI
MO. 20242

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1978

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National Dam Safety Program
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Jackson County, Missouri

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MISSOURI-KANSAS CITY BASIN

LAKEWOOD DAM
JACKSON COUNTY, MISSOURI
MO. 20242

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1978

SUBJECT: Lakewood Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lakewood Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

28 SEP 1978
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

29 SEP 1978
Date

LAKEWOOD LAKE DAM

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20242

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lakewood Lake Dam
State Located	Missouri
County Located	Jackson County
Stream	West Fork of May Brook
Date of Inspection	8 August 1978

Lakewood Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers the estimated damage zone extends 20 miles downstream of the dam. Within the first mile of the damage zone are 6 homes and the bridge of one improved road. The flood plain is farmed.

~~Our~~ inspection and evaluation indicates the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass the probable maximum flood without overtopping.

Deficiencies visually observed by the inspection team were erosion and seepage indicated by moist soil near the east abutment on the downstream embankment slope. Seepage and stability analyses were not available for this dam. To satisfy the requirements of the guidelines, seepage and stability analyses should be on file for dams in the High Hazard classification.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to prevent further erosion on the embankment which could lead to the development of potential safety hazards. A detailed report discussing each of these deficiencies is attached.

Paul R. Zaman

Paul R. Zaman, PE
Illinois 62-29261

Bruce A. Ainsworth

Bruce A. Ainsworth, PE
Missouri E-18023

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF LAKE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKEWOOD LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Lakewood Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is a rolled earth structure located in the valley of the West Fork of May Brook in central Jackson County, Missouri (see Plate 1). A roadway has been constructed across the top of the dam. Topography of the contributing watershed is characterized by rolling hills. Land use consists of residential areas and farm land. Topography in the vicinity of the dam is shown on Plate 2. Lakewood (East) Lake is located to the east of Lakewood Lake. The two lakes are connected by a 110 feet wide boat channel, 15 feet deep at normal pool elevation (El.858.0). Lakewood Lake shall be referred to as Lakewood (West) Lake in this report.

(2) A spillway channel was excavated within the limestone strata in the west abutment. A bridge with twelve 11 by 6 feet box culverts was constructed in the spillway channel adjacent to the west abutment of the dam. Twelve 11 by 1 by 1 foot blocks were placed within the box culverts to raise the flow level through the culverts to El.859.0. A discharge channel was excavated from limestone and shale formations along the west valley wall.

(3) An outlet structure is located approximately 480 feet east of the centerline of the bridge and spillway channel. Its primary use was as a diversion structure.

(4) A drainage blanket was detailed as constructed along an area beginning 34 feet downstream from the centerline of the dam extending 124 feet downstream for the entire length of the dam (see Plate 5). An 8 inch perforated asbestos bonded corrugated metal pipe was shown embedded in the 8 feet thick drainage blanket at 1 foot above the bottom of the blanket. Three 12 inch asbestos bonded corrugated metal pipes extend from the perforated pipe to the downstream toe of the dam.

(5) A 30 inch sewer line runs through the embankment normal to the centerline of the dam approximately 350 feet west of the east abutment.

(6) A 12 inch water main is buried parallel to the longitudinal axis of the dam near the downstream side of the roadway on top of the dam.

(7) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in the central portion of Jackson County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle maps for Independence, Blue Springs, Lake Jacomo, and Lee's Summit, Missouri in Sections 5, 6, 7, and 8 of T48N, R31W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the intermediate size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Lakewood (West) Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways or railroads. The Lakewood (West) Lake Dam has an estimated damage zone which extends 20 miles downstream of the dam. Within the first mile of the damage zone are 6 homes and one improved road bridge. The flood plain is farmed.

e. Ownership. The dam is owned by Farm and Home Savings Association of Nevada, Missouri, 217 Bayview, Lee's Summit, Missouri 64063.

f. Purpose of Dam. The dam forms a 147 acre recreational lake.

g. Design and Construction History. The dam was designed primarily by the late Robert J. Spiegel, Consulting Engineer, Kansas City, Missouri. Construction began in 1969 by Andes and Roberts Construction Company, Independence, Missouri under the supervision of E. Daniel Weiskirk, P.E. Impoundment of water began in 1971. The boat channel between the west and east lakes was opened in 1975.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and seepage through the natural limestone and shale abutment all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - Combined drainage area of Lakewood (West) Lake and Lakewood (East) Lake is 3,410 (2,210 acres, Lakewood (West) Lake and 1,200 acres, Lakewood (East) Lake).

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled spillway. The water level could be lowered below normal pool elevation by use of the outlet works sluice gate.

(2) Estimated experienced maximum flood at damsite - unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation - 25,500 cfs (top of west dam).

c. Elevation (Feet Above M.S.L.).

(1) Top of dam - 869.0 ± (see Plate 3)

(2) Spillway crest - 859.0 (West dam box culverts), 858.0 (East dam drop inlet)

(3) Streambed at centerline of dam - 784.±

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 7,200 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 2,993 (from 1974 inventory for west lake only)

(2) Spillway crest - 2,639 (from 1974 inventory for west lake only)

(3) Normal lake elevation (858.0) - 5,943 (from design calculations for total in east and west lakes)

(4) Design Surcharge - 2,800

f. Reservoir Surface (Acres).

(1) Top of dam - 440

(2) Spillway crest - 235 (from design calculations)

g. Dam.

(1) Type - rolled earth embankment

(2) Length - 1,200 feet

(3) Height - 84 feet maximum (from 1974 inventory)

(4) Top width - 60 feet

(5) Side Slopes - (see Plate 5)

(6) Zoning - Composed of impervious core supported by random fill on both faces (see Plate 5).

(7) Impervious Core - Vertically extends throughout the entire height of the dam with a 20-foot top width and 1 to 1 side slopes (upstream face) and 1 to 0.5 side slopes (downstream face) (see Plate 5).

(8) Cutoff - (see Plate 5)

(9) Grout curtain - approximately 53 grouting holes 250 feet each side of the spillway channel centerline.

h. Diversion and Regulating Tunnel - 36 inch diameter reinforced concrete pipe with 5-3/4 inch wall thickness. Located near west abutment with the sluice gate operator by road at top of dam.

i. Spillway.

(1) Type - concrete and rock (see paragraph 3.1c)

(2) Length of weir - 132 feet (see paragraph 3.1c)

(3) Crest elevation - 858.0 feet m.s.l. (East dam drop inlet)
859.0 feet m.s.l. (West dam box culverts)

(4) Gates - none

(5) Upstream Channel - concrete approach channel.

(6) Downstream Channel - Excavated from the natural abutment and lined with broken limestone and shale. Side slopes one mile downstream of dam are typical of streams in the area.

j. Regulating Outlets - 36 inch diameter reinforced concrete pipe with a wall thickness of 5-3/4 inches. A 36 inch diameter Rodney Hunt Series HY-Q-280 sluice gate is provided with an 80.5 feet seating head. The pipe invert elevation is 781.0. An outlet structure is provided with an operator at El.868.0.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data was made available by Andes and Roberts Construction Company and Earl C. Meserve, P.E. The data included design and as-built drawings, hydraulic and hydrologic calculations, and post-construction inspections and seepage flow records.

2.2 CONSTRUCTION

The dam was constructed in 1969 and 1970 by Andes and Roberts Construction Company of Independence, Missouri. As-built drawings and data were obtained from Andes and Roberts Construction.

2.3 OPERATION

The maximum recorded loading on the dam is unknown. Several post-construction studies have been performed since the impounding of water began. In the winter of 1976 seepage measurements were undertaken by Earl C. Meserve and continued through much of 1977. Records were made of seepage through both the East and West dams. During the period of May through September, 1977 a water balance study was conducted by Woodward-Clyde Consultants, Kansas City, Missouri. A visual inspection of the dam and review of available data was performed subsequent to the above study by Woodward-Clyde.

2.4 EVALUATION

a. Availability. Engineering data in the form of background reports, as-built drawings, and construction records were available from Andes and Roberts Construction Company and Earl C. Meserve, P.E. No other engineering data were found.

b. Adequacy. The engineering data available were inadequate to make a detailed assessment of design, construction, and operation. Seepage and stability analyses are necessary to satisfy the requirements of the guidelines.

c. Validity. The engineering data available were insufficient to determine the validity of the design, construction, and operation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Lakewood (West) Lake dam was made on 8 August 1978. The inspection team included professional engineers with experience in dam design and construction, hydrologic - hydraulic engineering, and geotechnical engineering. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following items at the dam. Some erosion was observed along the east abutment. The surface was eroded 3 to 4 feet exposing rock, but no seepage was evident at this location. Immediately downstream of the rock fill along the downstream toe near the east abutment soft ground was noted indicating some seepage. Excessive vegetal growth along downstream slope should be controlled. Seepage was observed in the discharge channel immediately downstream of the spillway, but has little affect on the embankment integrity.

c. Appurtenant Structures. The spillway consists of a concrete-lined approach channel with twelve 11 by 6 feet concrete box culverts which provide the support for the roadway over the spillway. Twelve 11 by 1 by 1 foot blocks increase the flow level through the culverts by 1 foot. Flow from the reservoir must pass through either the box culverts or the boat channel unless the outlet works gate is opened. The spillway and approach channel appear in good condition. Excessive seepage of approximately 50 gpm was observed between the limestone strata of the discharge channel walls about 150 feet downstream of the spillway. No water was discharging through the outlet culvert at the time of inspection. The outlet works sluice gate operator could not be checked for operation because it was locked. A 10.5 by 15.0 feet concrete drop inlet structure permits discharge from the east lake at El.858.0 which is 1 foot lower than the invert of the 12 box culverts at the west spillway (El.859.0). Flow entering the drop inlet discharges through a 6 by 5 feet inlet discharge culvert to a stilling basin near the downstream toe of the east dam. An emergency spillway channel is provided on the east dam across the road (El.862.0). Spillway discharge flows from the 12 box culverts to an excavated limestone and shale discharge channel. The east spillway training wall is cracked. About 50 feet downstream of the box culverts there is a slight erosion of the shale layers within the channel.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir.

e. Downstream Channel. Heavy vegetation and mild slopes typical of streams in the area characterize the area approximately 500 feet downstream of the spillway.

3.2 EVALUATION

Items observed in the visual inspection which need to be monitored are seepage along the spillway discharge channel and downstream toe of the embankment and erosion at the east abutment. These items if left uncontrolled could lead to further deterioration of the embankment integrity resulting in an increased potential of failure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Controlled outlet works exist, but are not used as a regulating facility. The pool is primarily controlled by rainfall, runoff, evaporation, seepage through the natural limestone and shale abutment, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown.

4.3 MAINTENANCE OF OPERATING FACILITIES

There is no evidence of maintenance having been performed on the outlet structure.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Existing seepage indicated by moist soil at the downstream toe near the east abutment, although minor, along with erosion and vegetation on the downstream slope increases the potential for failure and warrants regular monitoring and control.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Report and as-built drawings were available. Design calculations were available for hydrology and hydraulics.

The embankment and appurtenant structures were designed primarily by Robert J. Speigel, Consulting Engineer. The hydraulic and hydrologic computations were performed by Earl C. Meserve, Consulting Engineer. Mr. Meserve's calculations show the inflow hydrographs for the east and west lakes were calculated by using Clark's unitgraph with parameters of Tc = 2.0 hours and R = 2.0 hours. The inflows were calculated based on a rainfall of 50 percent of the 6-hour probable maximum precipitation or 13.0 inches in 6 hours. The assumption was made that 100 percent of the precipitation ran off.

With the design infows calculated for each lake as indicated above, the peak inflows for the east and west lakes were determined to be 3,181 cfs and 5,709 cfs respectively. A peak inflow of 8,859 cfs for 50 percent of the probable maximum flood, referred to as the "spillway design flood (SDF)" in the calculations, was routed through the reservoirs. To determine outflow discharges for the reservoirs the discharge ratings for the spillways and outlets were calculated individually. Discharges for the twelve 11 by 6 feet box culverts of the west dam spillway were calculated by use of the broad-crested weir equation:

$$Q = CLH^{1.5}$$

C = 2.6, L = 132 feet, H = head on weir

To force the majority of the outflow from the two reservoirs to discharge through the east dam drop inlet, twelve 11 by 1 by 1 foot blocks were placed at the inverts of the west dam spillway box culverts to prevent flow in the west spillway unless inflows resulted in the lake levels exceeding an elevation 1 foot higher than the drop inlet elevation. The rating curve for the west spillway was changed only by using the same discharges calculated previously and increasing the corresponding elevations by 1 foot. The resulting design discharge capacity with the reservoir level at the top of dam for the west dam spillway box culverts was calculated at 9,270 cfs. The east dam drop inlet design dimensions of 10.5 by 15.0 feet yielded a design discharge capacity with the reservoir level at the top of dam of 1,010 cfs by calculating the controlling discharge in the inlet discharge culvert through the dam using the equation:

$$Q = A\,(2gH)^{0.5}$$

A = 30 sq ft, g = 32.2 ft/sec^2, H = 17.8 feet

When the inlet discharge culvert was not flowing full, at El.865.0 or below, the discharge was controlled by the equation:

$Q = CLH^{1.5}$
C = varied from 4.0 to 1.9 depending on the head on the weir
L = 27.5 feet, H = head on the weir up to 8 feet at El.865.0

An emergency spillway was designed for the west abutment of the east dam. The design discharges for the east dam emergency spillway were calculated using the equation:

$Q = CLH^{1.5}$
C = 3.52, L = 40 feet, and H = head on the weir

The design discharge at the top of dam was 1,570 cfs. The combined design outlet discharge at the top of dam was determined to be 11,850 cfs. At the design freeboard of 6 feet below top of dam (El.863.0) the design discharge capacity would total 3,540 cfs. The hydraulic effect of the boat channel connecting the two reservoirs was considered negligible in determining the hydraulics of the reservoirs. The boat channel did, however, provide justification for combining the hydraulic information of the two reservoirs to act as a single reservoir where lake elevations exceeded the invert of the boat channel (El.843.0).

b. Experience Data. The drainage area and lake surface area are developed from USGS Lees Summit and Lake Jacomo, Missouri Quadrangle Maps. The spillway and dam layout are from drawings provided by Andes and Roberts Construction Company.

c. Visual Observations.

(1) Concrete spillway and the spillway discharge channel are in good condition. Seepage was observed between the limestone and shale layers of the discharge channel.

(2) Drawdown facilities are available to evacuate the pool, see paragraph 3.1c.

(3) The spillway and exit channel are located at the west abutment. Spillway releases will not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will pass the probable maximum flood, which is the spillway design flood recommended by the guidelines, without overtopping. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Failure of the Lakewood (East) Dam is not anticipated to pose a serious hazard to the Lakewood (West) Dam due to the maximum drawdown from normal pool level being restricted to 15 feet by the boat channel invert (El.843.0). Failure of upstream

water impoundments shown on the 1975 revised USGS map would not have a significant impact on the hydrologic or hydraulic analysis as the storage of these reservoirs was not considered. However the effect of total failure of these dams has not been investigated.

According to the St. Louis District, Corps of Engineers, the estimated damage zone extends 20 miles downstream of the dam. Within the first mile of the damage zone are 6 homes and one improved road bridge. The flood plain is farmed.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found.

c. Operating Records. No operational records exist.

d. Post Construction Changes. No post construction changes exist which will affect the structural stability of the dam.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone.

The seismic stability of an earth dam is dependent upon a number of factors: the important factors being embankment and foundation materials and shear strengths; abutment materials, conditions, and strength; embankment zoning; and embankment geometry. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment was not available and therefore no inferences will be made regarding the seismic stability.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items were noted during the visual inspection by the inspection team which should be monitored or controlled. Erosion along the east abutment and downstream toe westward from the center of the dam, vegetal growth on the downstream slope, and the seepage at the downstream toe near the east abutment indicated by moist soil in that area are of concern. The seepage of approximately 50 gpm observed in the west wall of the discharge channel between the natural limestone and shale formations approximately 150 feet downstream of the spillway, although excessive, is probably not relevant in evaluating the integrity of the embankment. Additional minor seepage was observed at other locations in the walls of the discharge channel. These other seepage areas probably do not adversely effect the integrity of the dam.

b. Adequacy of Information. Due to the inadequacy of engineering design data on the embankment and the absence of seepage and stability analyses, the conclusions in this report were based on performance history, review of drawings, hydrologic/hydraulic calculations, and construction information, and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. However, seepage and stability analyses are necessary to satisfy the requirements of the guidelines.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 could be accomplished now or delayed until observations of this monitoring program and/or the recommendation of a qualified engineer indicate the necessity for action. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. Presently, immediate action is not considered necessary.

d. Seismic Stability. This dam is located in Seismic Zone 1. Because stability analyses are not available, the seismic stability of the dam cannot be assessed.

7.2 REMEDIAL MEASURES

a. Alternatives. No measures are recommended.

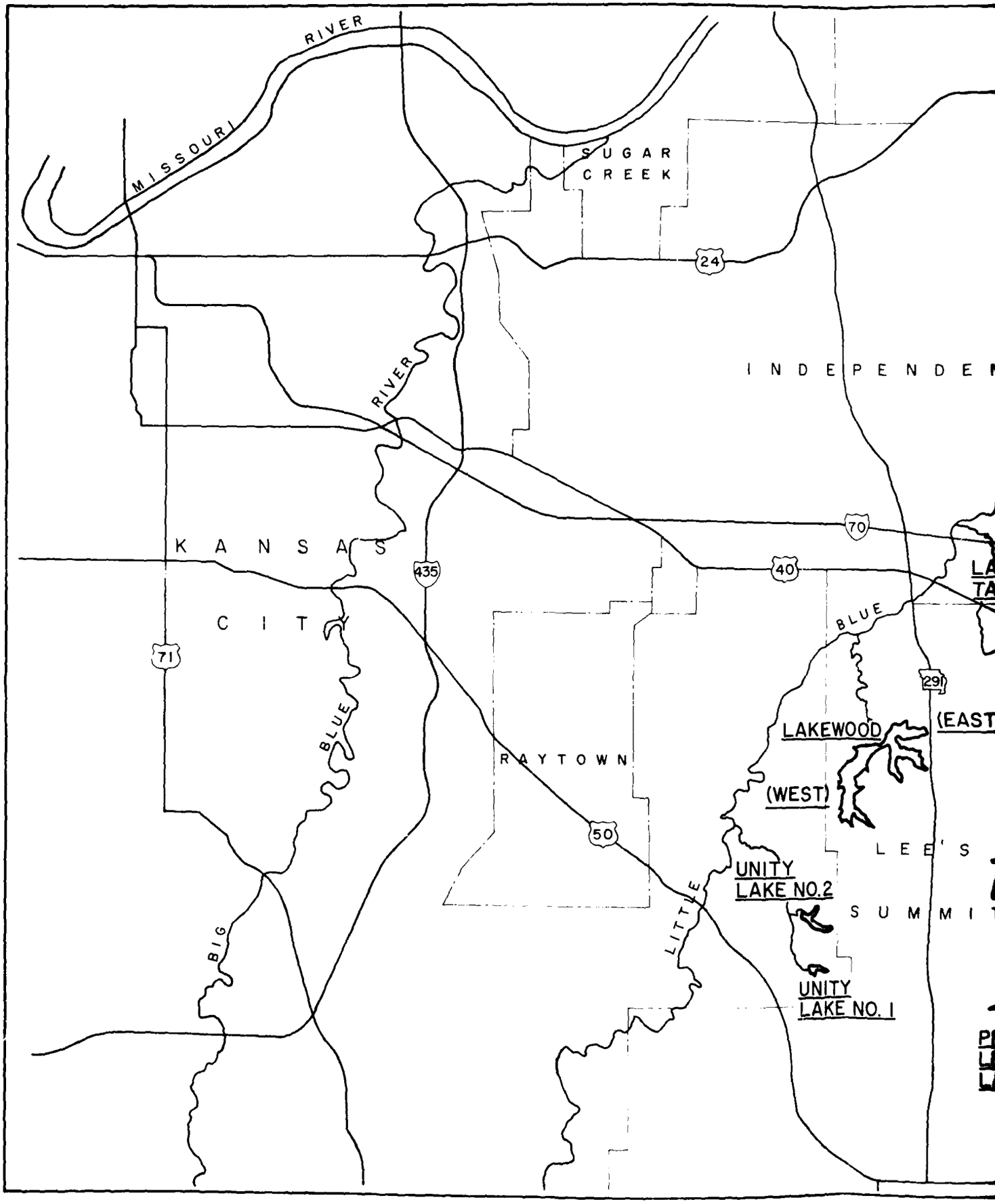
b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

(1) Check the downstream face of the dam periodically for seepage and stability problems. If increased seepage flows are observed or deterioration of the foundations of the embankment noted, the dam should be inspected and the pending condition evaluated by an engineer experienced in design and construction of earthen dams.

(2) Measures to curtail seepage along the spillway could be undertaken to minimize water loss.

(3) A regular maintenance program should be initiated to control the growth on downstream slope of the dam.

(4) A detailed inspection of the dam should be made at least every year by an engineer experienced in design and construction of dams. More frequent inspections may be required if items of distress are observed other than those already mentioned.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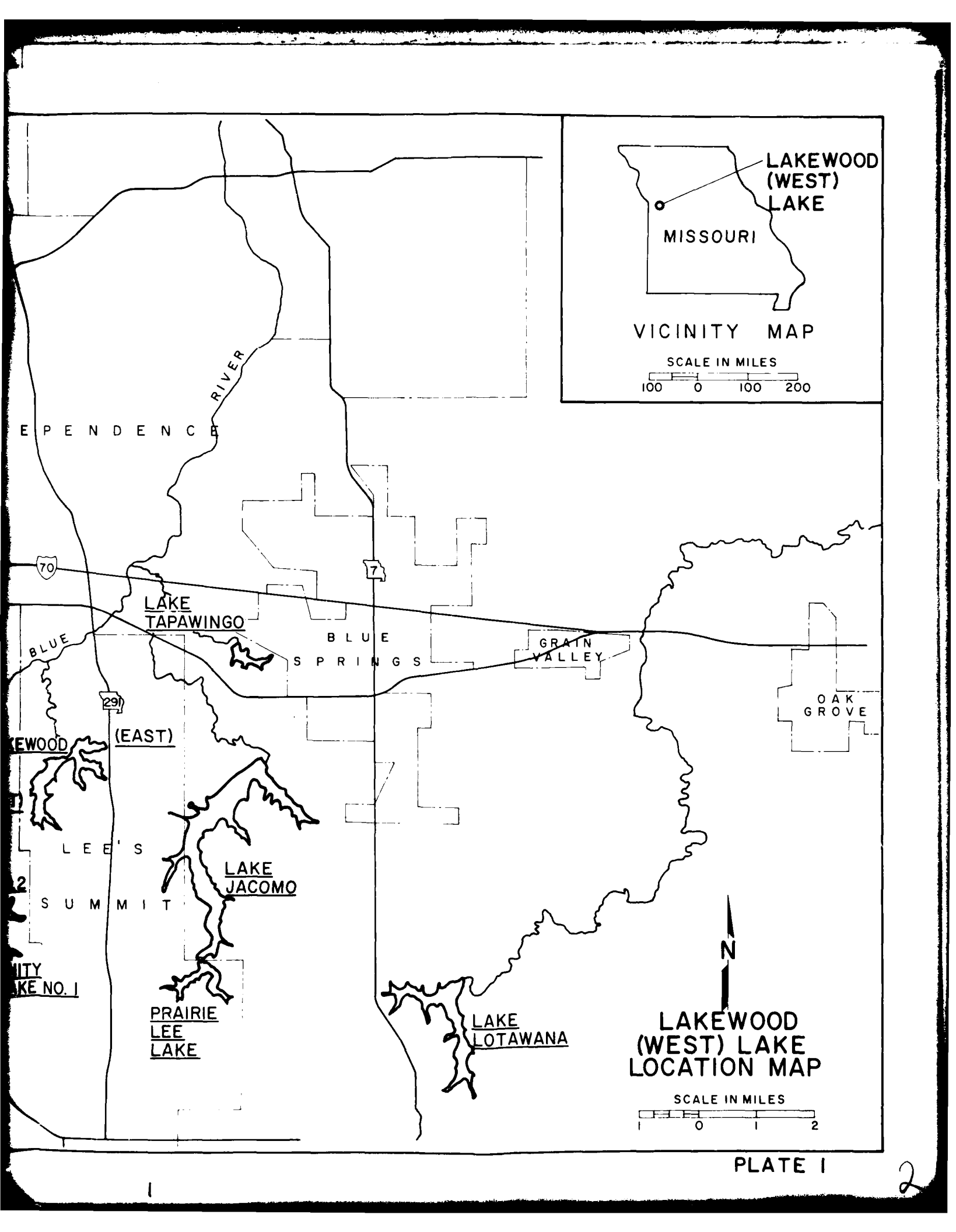
LAKEWOOD (WEST) LAKE
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L E E ' S
S U M M I T
LAKE JACOMO
PRAIRIE LEE LAKE
LAKE LOTAWANA
N
LAKEWOOD (WEST) LAKE LOCATION MAP
SCALE IN MILES
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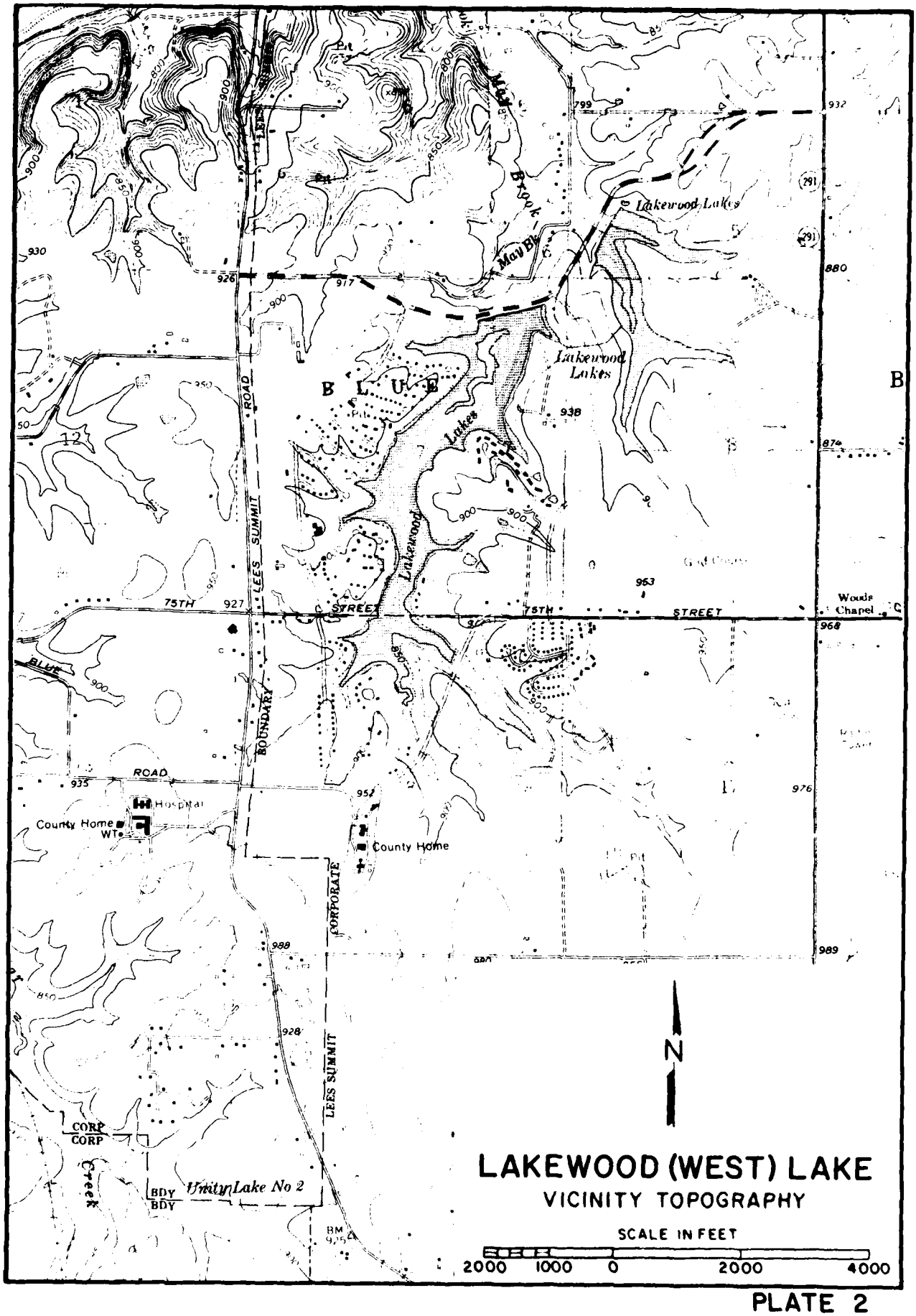
PLATE 1

2


Lakewood Lakes
May Brook
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LEES SUMMIT ROAD
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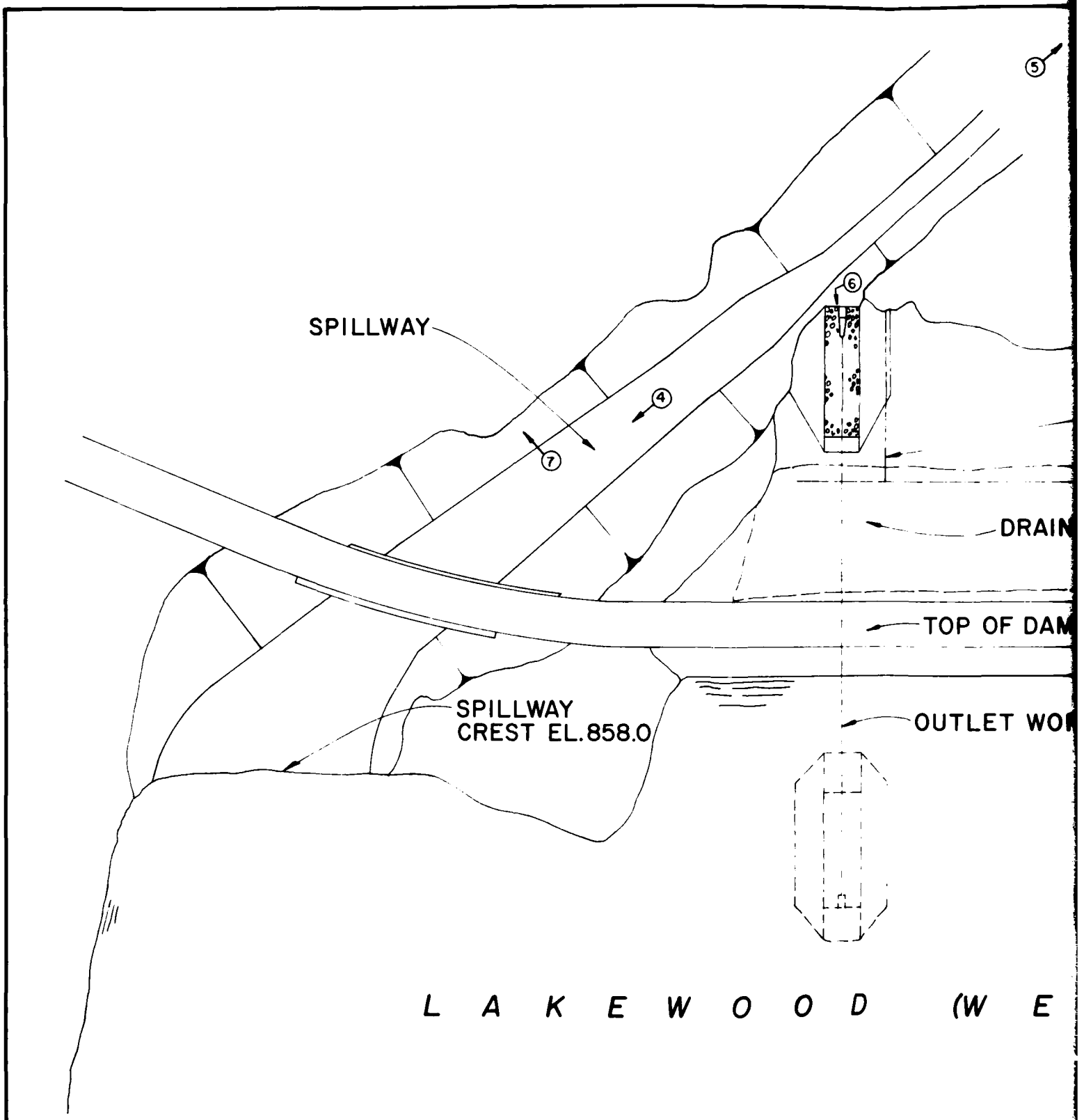
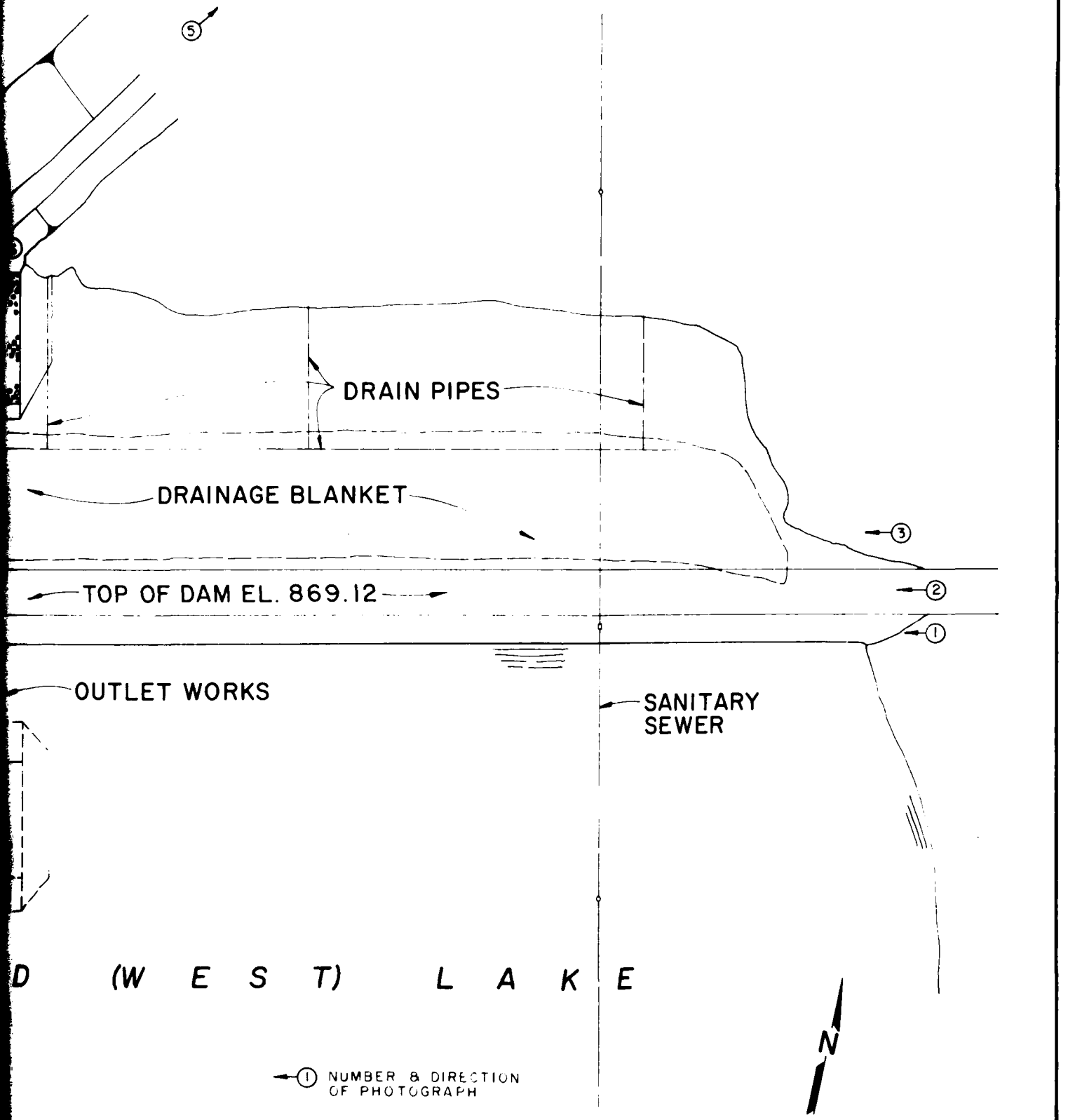
Woods Chapel
BLUE
BOUNDARY
ROAD
Hospital
County Home
WT
County Home
CORPORATE
LEES SUMMIT
CORP
CORP
Creek
Unity Lake No 2
BDY
BDY
BM
N
LAKEWOOD (WEST) LAKE
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000

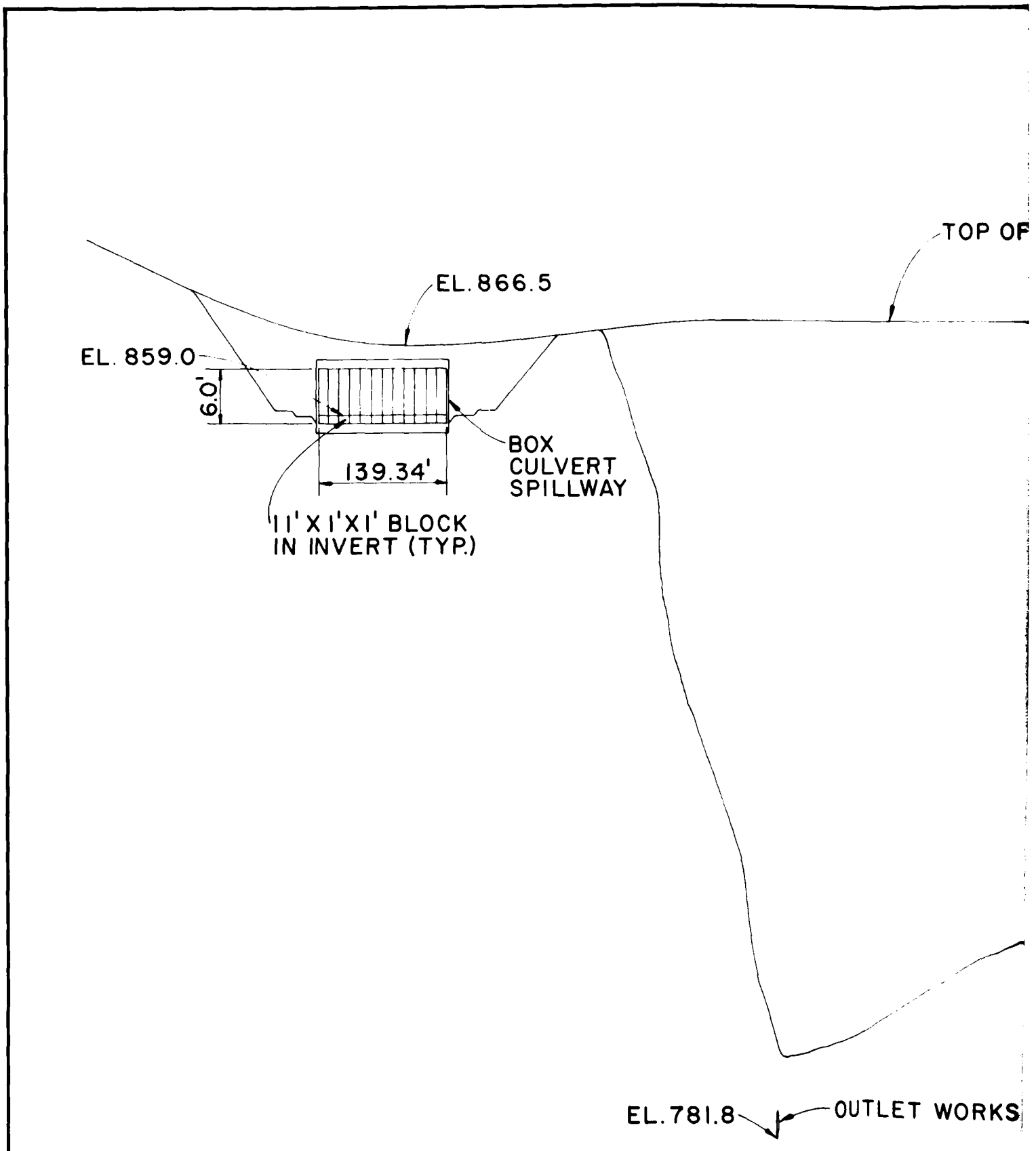
PLATE 2

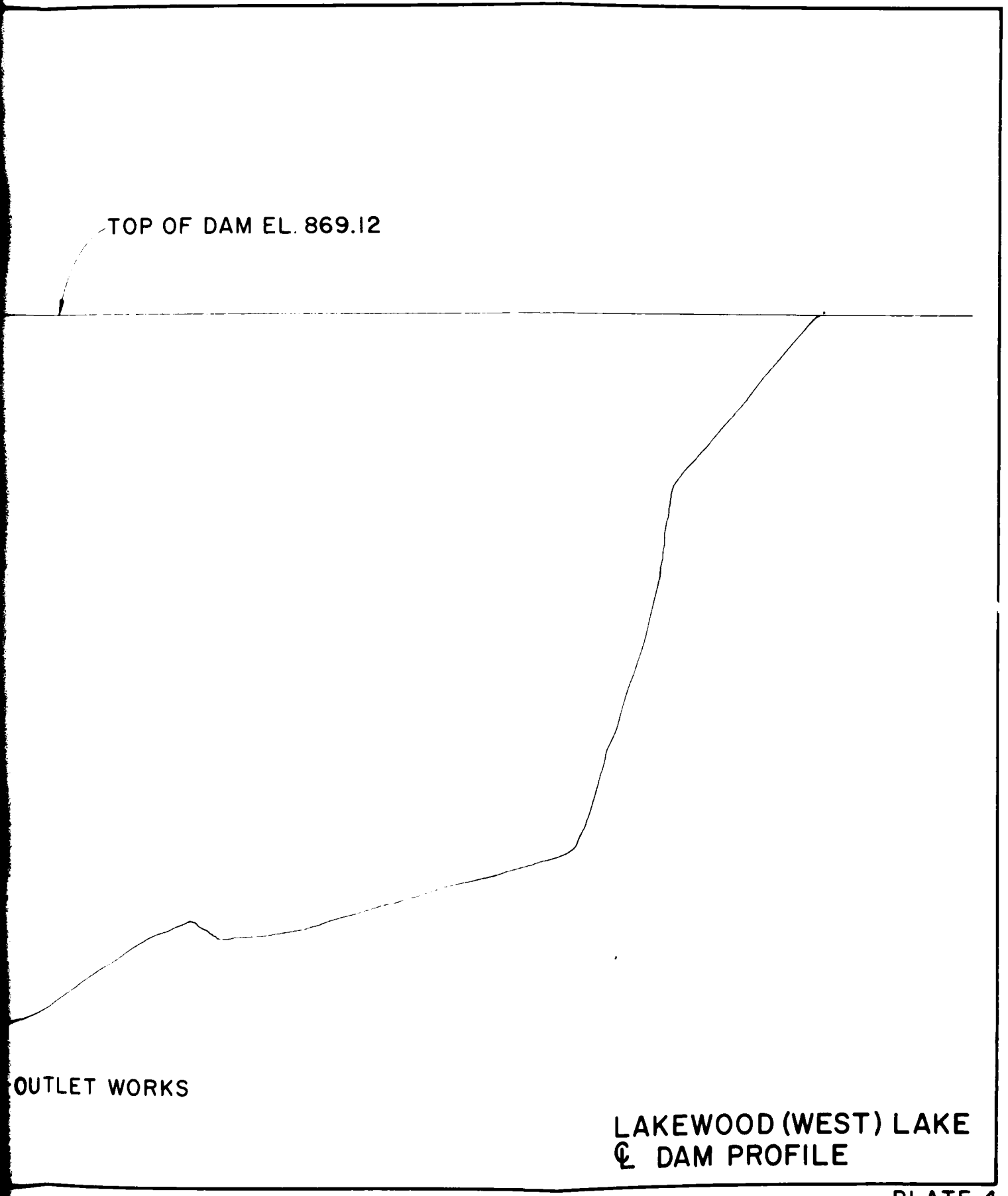

SPILLWAY
DRAIN
TOP OF DAM
SPILLWAY
CREST EL. 858.0
OUTLET WOR
LAKEWOOD (WE



LAKEWOOD (WEST) LAKE PLAN

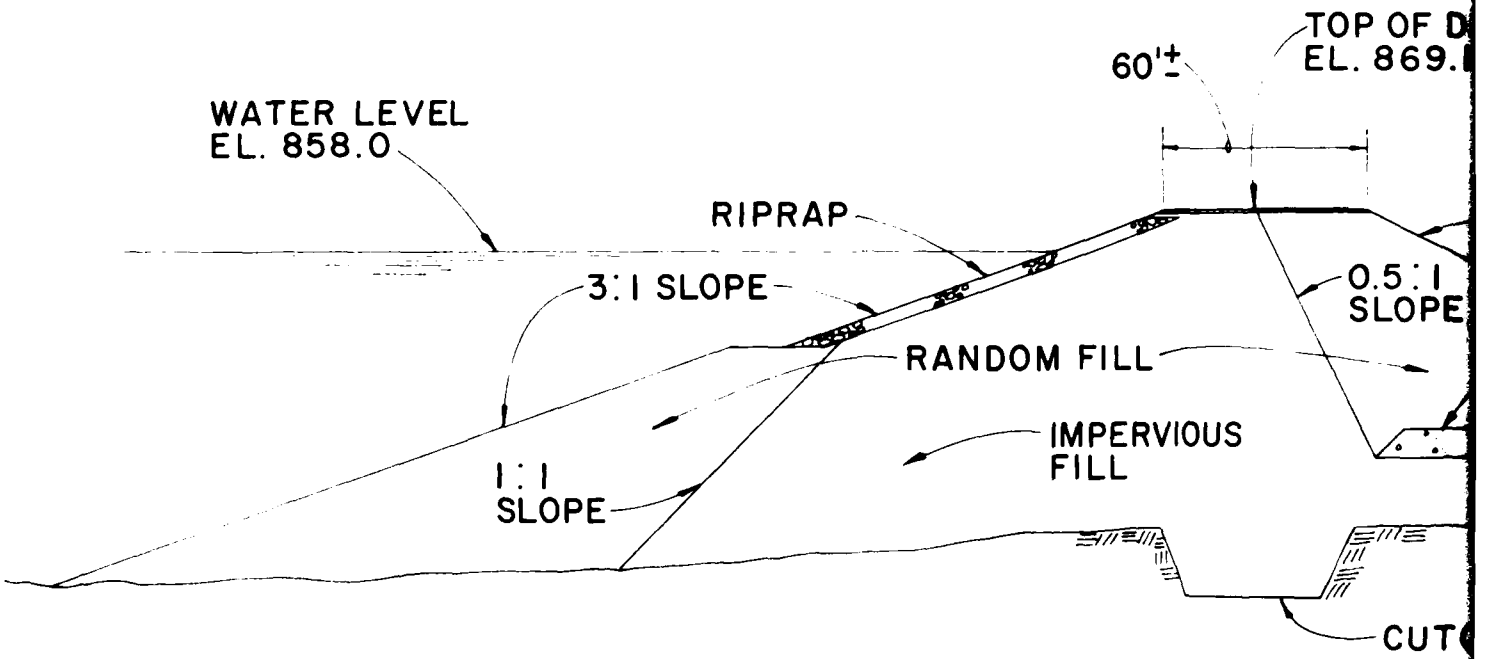
PLATE 3

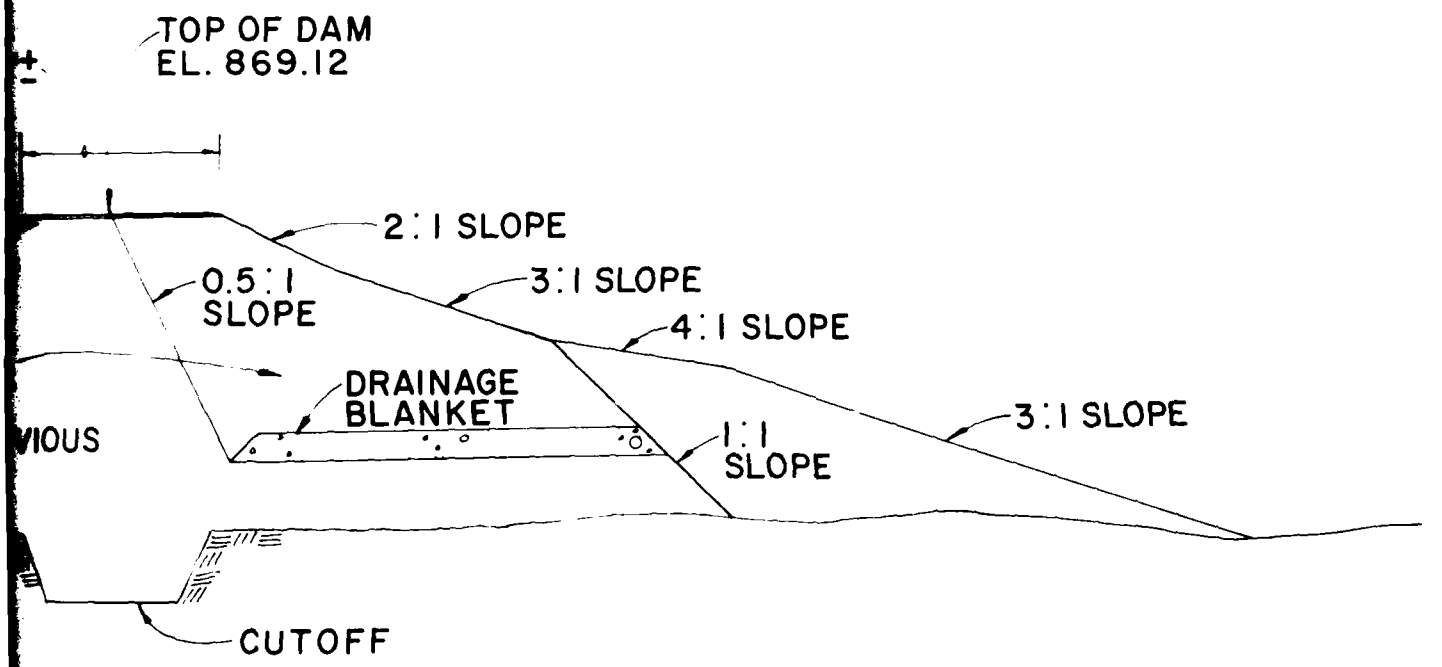

TOP OF
EL. 866.5
EL. 859.0
6.0'
139.34'
BOX
CULVERT
SPILLWAY
11'X1'X1' BLOCK
IN INVERT (TYP.)
EL. 781.8
OUTLET WORKS



LAKEWOOD (WEST) LAKE
℄ DAM PROFILE

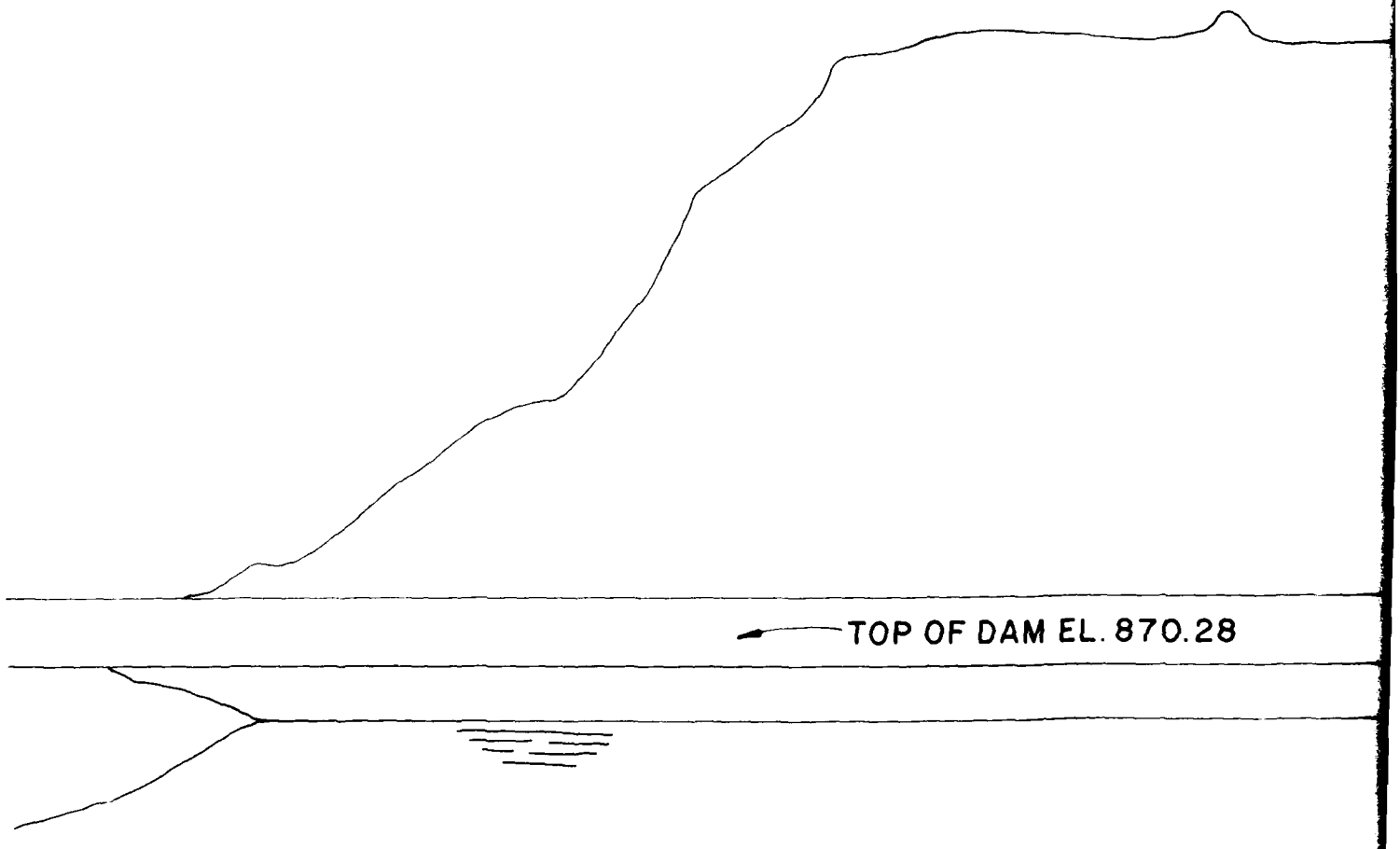
PLATE 4


TOP OF D
EL. 869.
60'±
WATER LEVEL
EL. 858.0
RIPRAP
3:1 SLOPE
0.5:1
SLOPE
RANDOM FILL
IMPERVIOUS
FILL
1:1
SLOPE
CUT

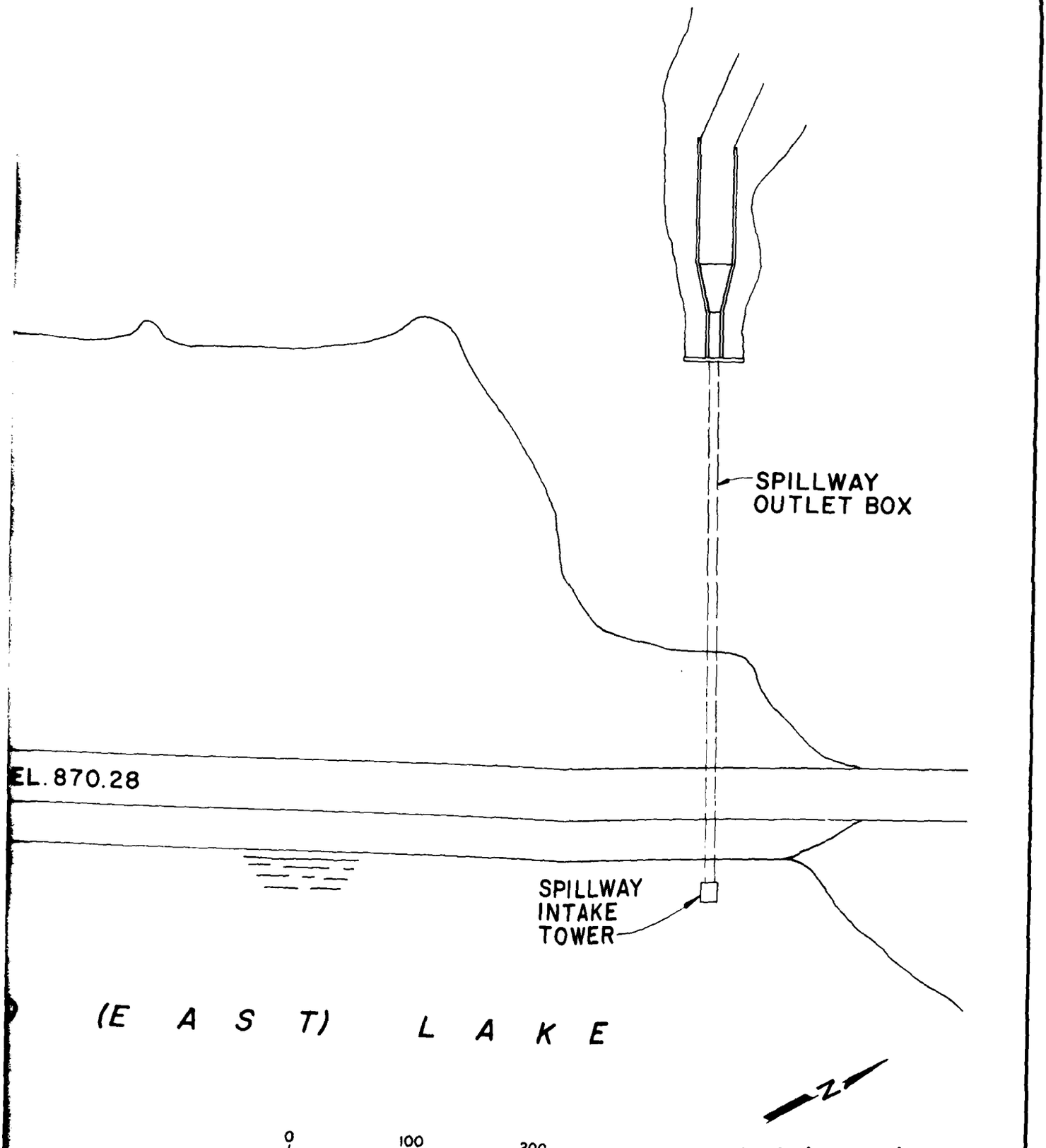


LAKEWOOD (WEST) LAKE
TYPICAL SECTION

PLATE 5

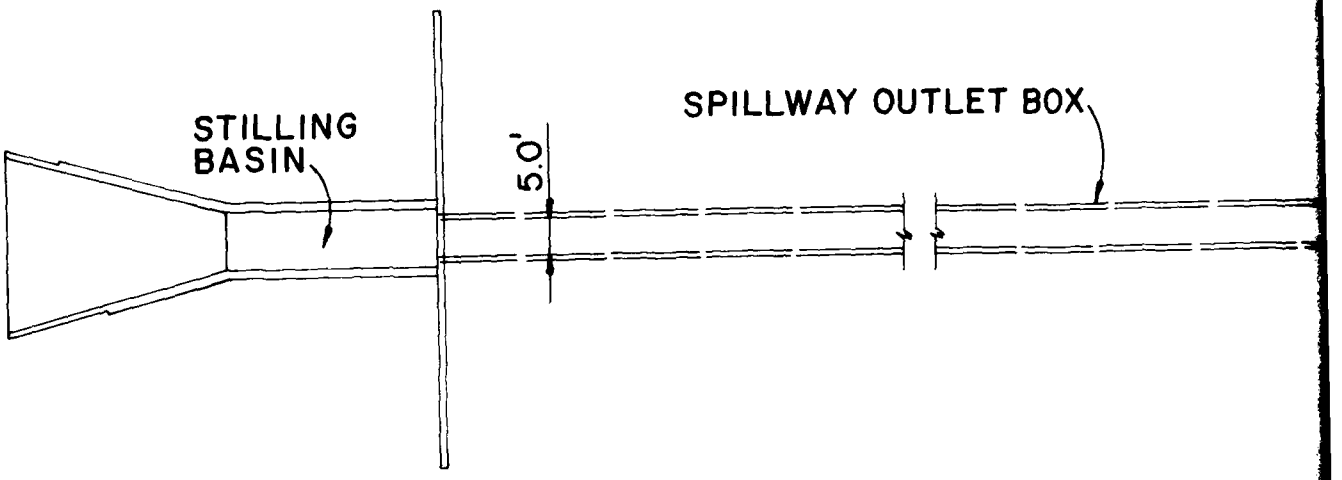


L A K E W O O D (E A

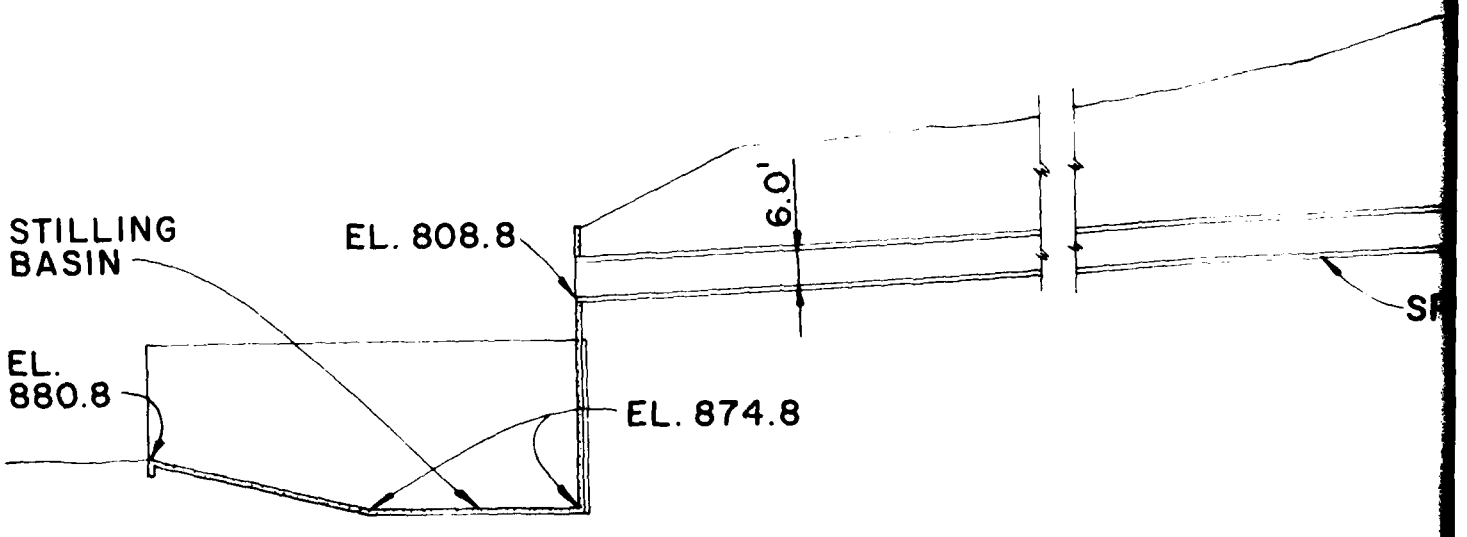


LAKEWOOD (EAST) LAKE
PLAN

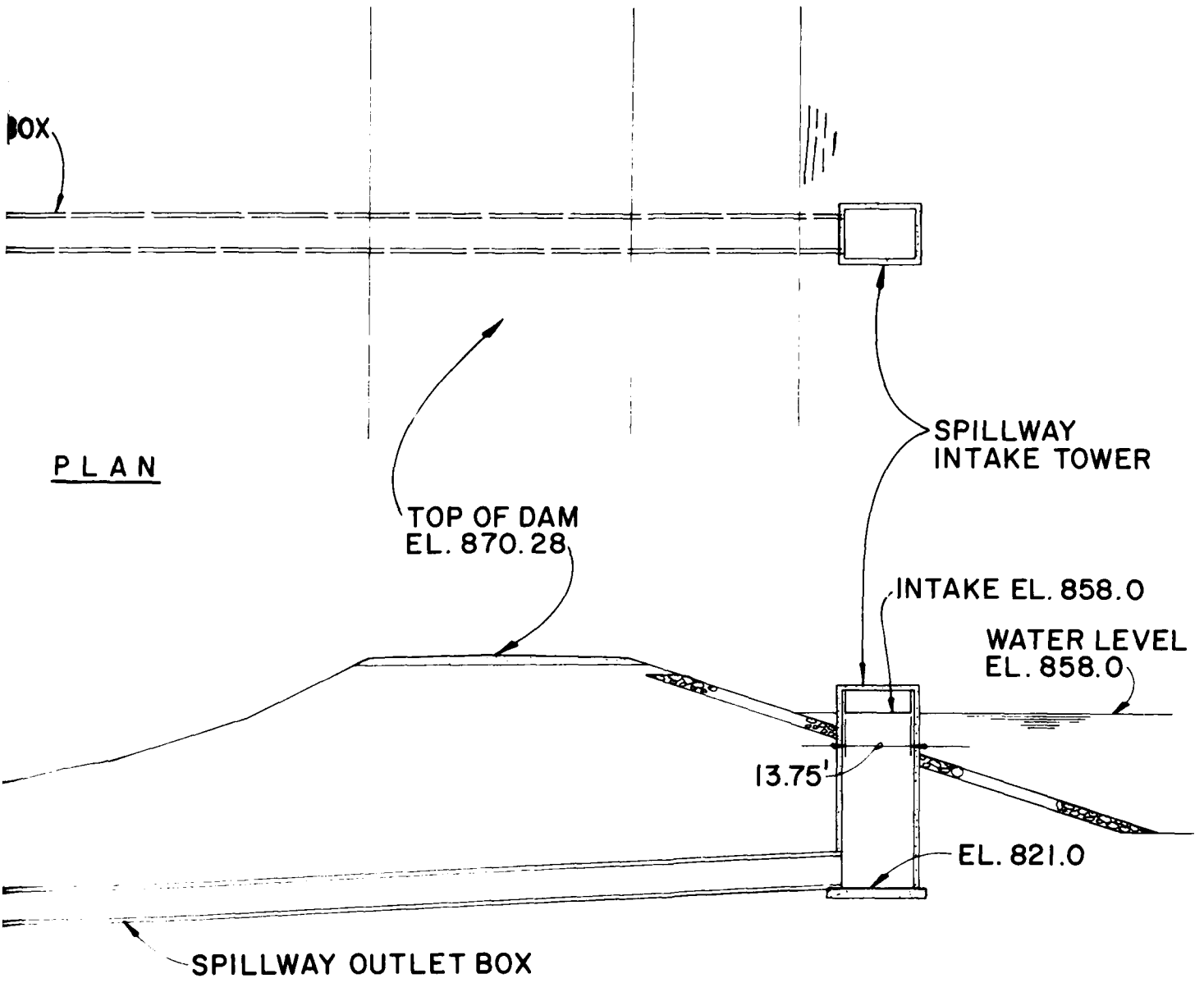
PLATE 6



PLAN



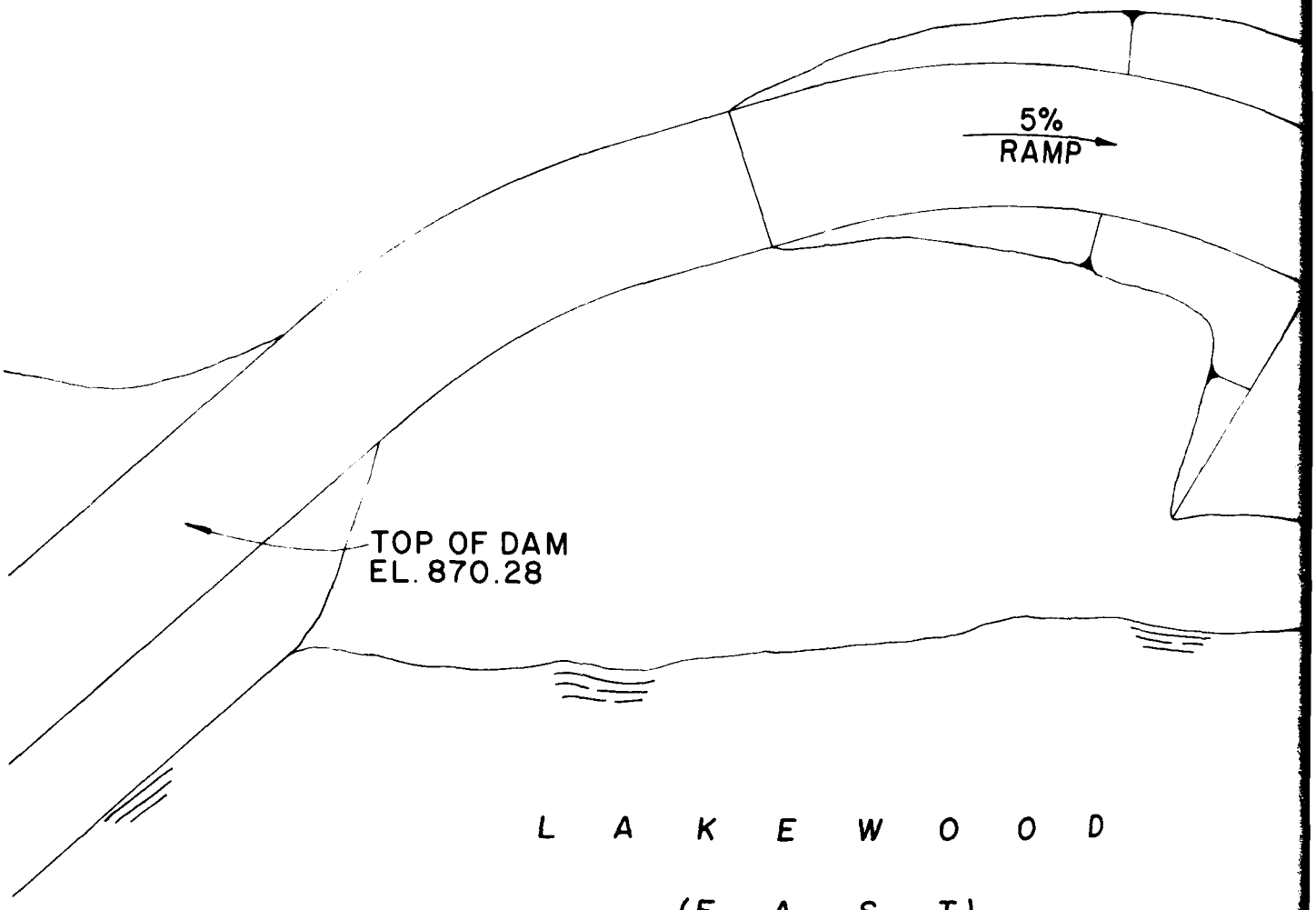
SECTION

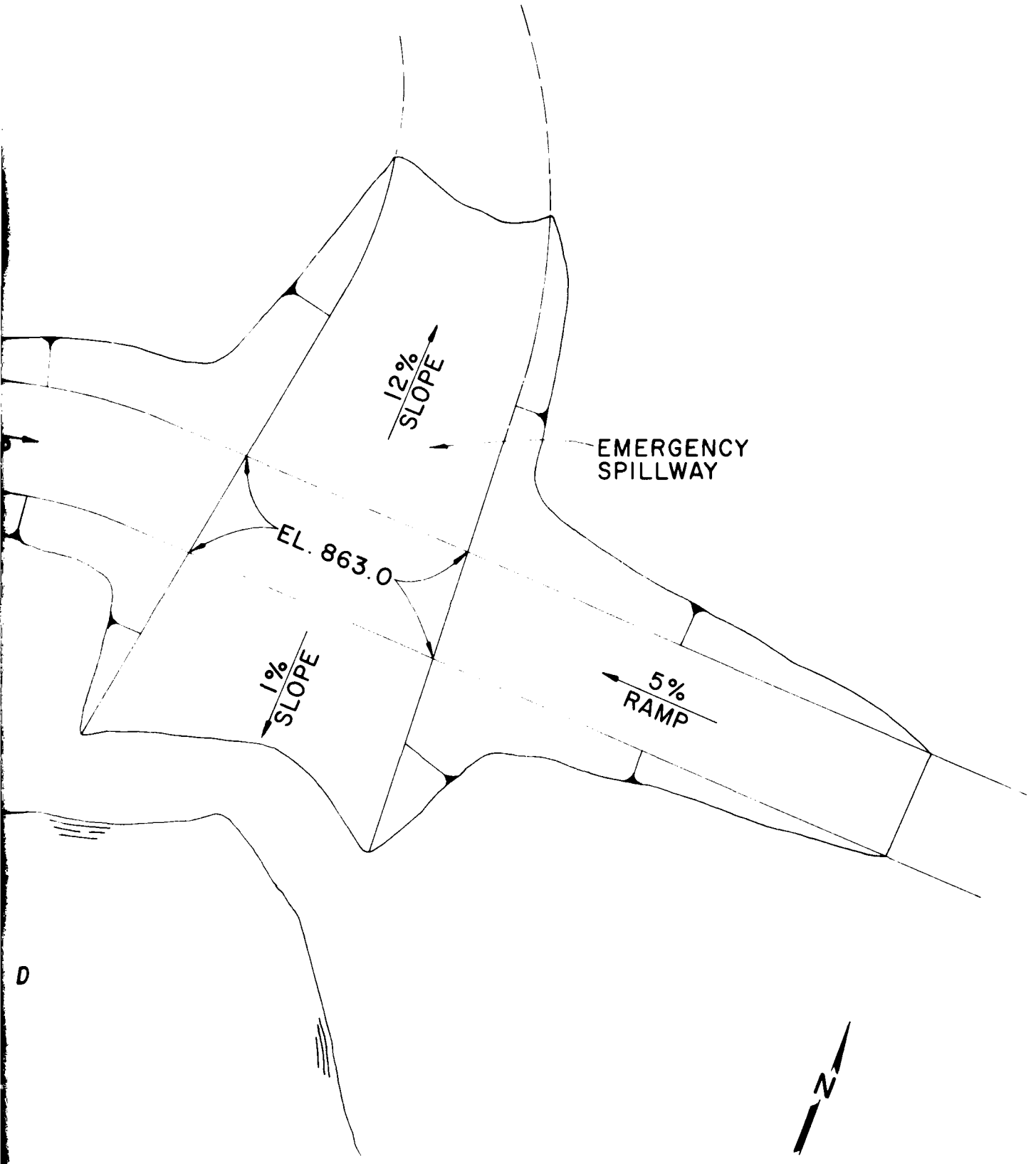


SECTION

LAKEWOOD (EAST) LAKE
DROP INLET SPILLWAY

PLATE 7


5%
RAMP
TOP OF DAM
EL. 870.28
L A K E W O O D
(E A S T)
L A K E



D

LAKEWOOD (EAST) LAKE EMERGENCY SPILLWAY

PLATE 8

PHOTO 1: UPSTREAM FACE OF DAM (LOOKING WEST)

PHOTO 2: TOP OF DAM

PHOTO 3: DOWNSTREAM FACE OF DAM (LOOKING WEST)

PHOTO 4: LOOKING UPSTREAM AT SPILLWAY DISCHARGE CHANNEL

PHOTO 5: DOWNSTREAM OF DISCHARGE CHANNEL

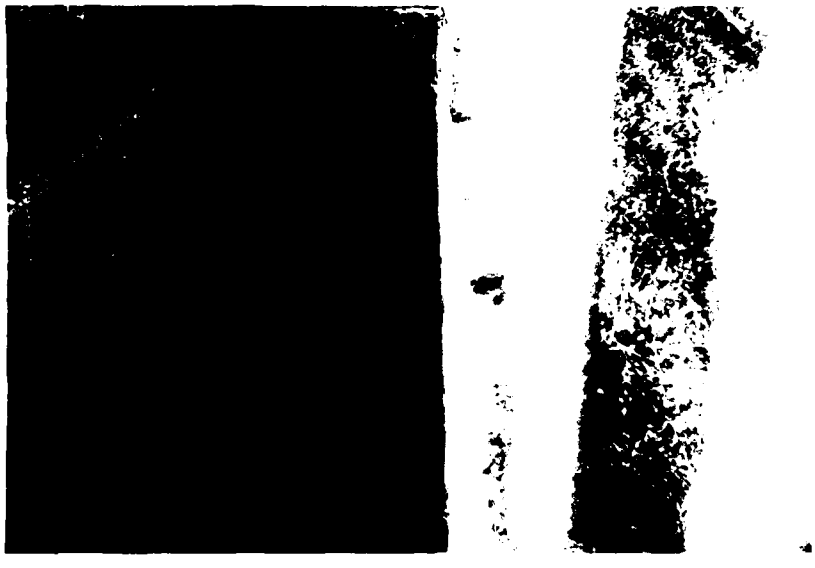


PHOTO 6: DISCHARGE PIPE OF OUTLET WORKS

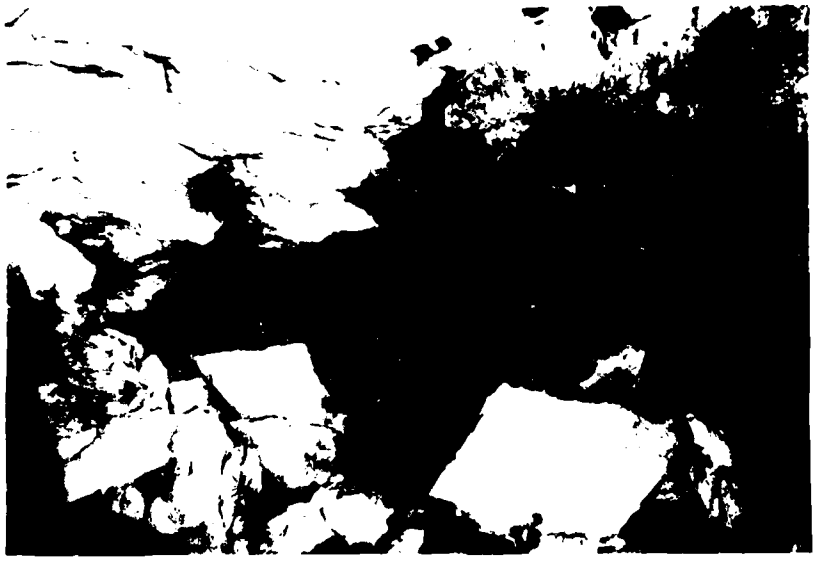


PHOTO 7: SEEPAGE ON LEFT WALL OF SPILLWAY CHANNEL

PHOTO 8: HOMES IN DOWNSTREAM HAZARD ZONE

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrograph (see Plate A-1) and hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33:

200 square mile, 24 hour rainfall	- 24.8 inches
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%

b. Drainage area = 3,410 acres (2,210 acres, West Lake + 1,200 acres, East Lake)

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385}$ = 47 minutes (West Lake), 18 minutes (East Lake) (L = length of longest watercourse in miles, H = elevation difference in feet) (2)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 76 and antecedent moisture condition III.

2. The spillway release rates for the box culverts on the west dam were determined by using the equation:

$$Q = wg^{0.5}(H/1.5)^{1.5}$$

w = 132 feet (net width of box culverts),
H = head above the box culvert invert

When the reservoir elevation rose over the top of road over the box culverts, additional discharge was determined using the broadcrested weir equation:

$$Q = CLH^{1.5}$$

C = 2.6, L = variable length of weir in feet, H = head on the weir (above the top of road elevation)

Releases from the drop inlet spillway of the east dam were calculated by using:

$$Q = CLH^{1.5}$$

C = 2.98 to 3.32, L = 27.5 feet, H = head on inlet weir.

The drop inlet discharge culvert controlled the flow from the inlet where the reservoir level exceeded El.862.0. At this point the discharge was calculated by using the equation:

$$Q = 119.03h_L^{0.5}$$

h_L = head measured from the top of the discharge culvert to the reservoir elevation.

The above equation was derived from:

$$h_L = K_b V^2/2g + n^2V^2L/2.22R^{1.33} + V^2/2g$$

K_b = 1.5, n = 0.018, L = 256 feet, R = 1.36 feet using an area of 30 sq. ft. for the discharge culvert

Discharges from the east dam emergency spillway were determined from the equation:

$$Q = CLH^{1.5}$$

C = 3.087, L = varied length of weir in feet,
H = head on the weir in feet.

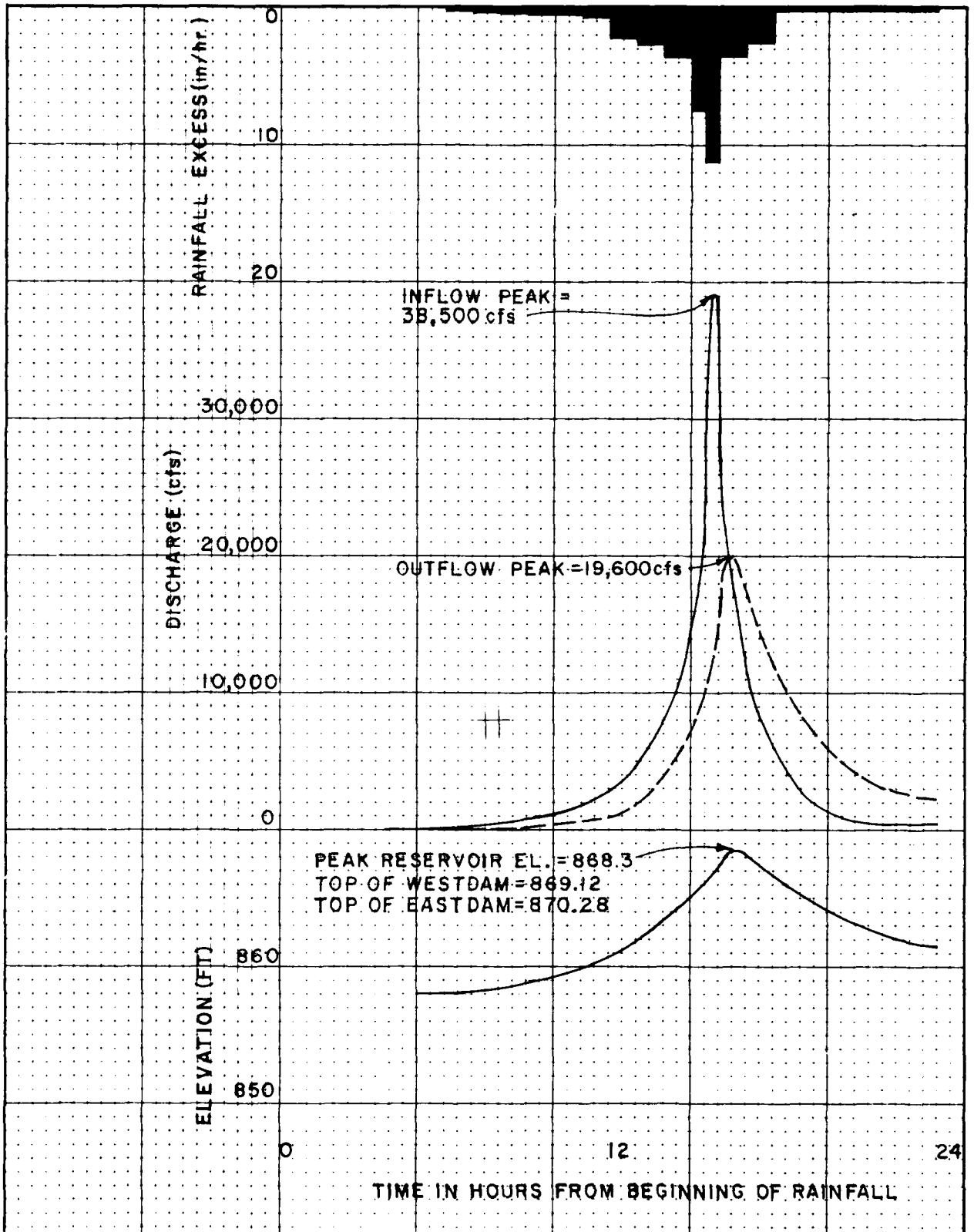
The discharges as calculated above were combined at their respective elevations to produce a discharge rating curve for the two interconnected reservoirs.

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway. Inflow and outflow hydrographs are shown on Plate A-1.

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July, 1978, Davis, California.

(2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.



LAKEWOOD LAKES
PROBABLE MAXIMUM FLOOD
HYDROGRAPH, HYETOGRAPH

PLATE A-1